IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF
SERIAL NO: 10/565,696
FILED: 01/24/2006
FOR: RESIN FOR RESIST, POSITIVE RESIST COMPOSITION, AND METHOD OF FORMING RESIST PATTERN
EXAMINER: RICHARD A. HUHN
GROUP ART UNIT: 1796

DECLARATION UNDER 37 C.F.R. § 1.132

ASSISTANT COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313-1450

SIR:

I, Hideo HADA, a Japanese citizen residing at Kawasaki-shi, declare and state that:

I entered Tokyo Ohka Kogyo Co., Ltd., Japan, on April,1994 , and am engaged in the research and development of works relative to the resins for resist, positive resist compositions and other related products of the company.

I am one of the Applicants of the above-identified application and I am very familiar with the present case.

I have a good knowledge of the English language and have read and understood the application papers and the prosecution history of this and the antecedent applications as well as the Examiner's references cited therein.

PURPOSE, METHOD AND RESULTS

(I) Purpose of these experiments:

One purpose of the Experiments described in this declaration is to show that a resin for a resist which meets the restrictions described in claim 8 of the present application has remarkable effects in resolution, depth of focus (DOF), and mask error factor (MEF).

Here, the Applicant is especially focused on the cases where the structural unit represented by general formula (V) is used as the structural unit (a2) of the present invention, because the cases of using the structural unit represented by general formula (VI) (claim 8) as the structural unit (a2) is shown in Examples of the present application.

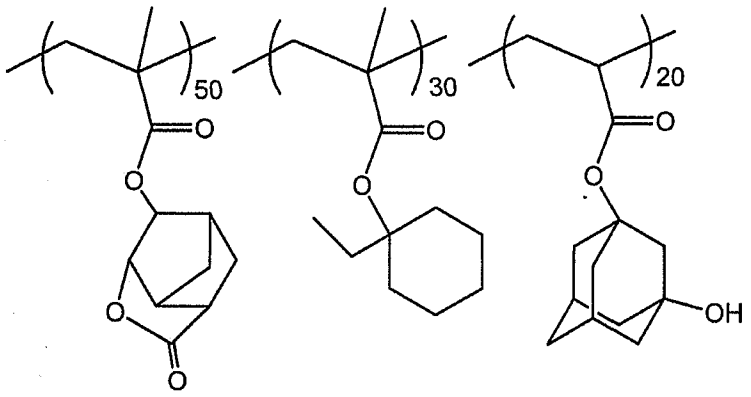
Also, another purpose thereof is to show that even if the structural unit represented by general formula (V) is used as the structural unit (a2), the effects of the present invention cannot be attained in the case of using the structural unit which includes an acid dissociable, dissolution inhibiting group containing a polycyclic aliphatic hydrocarbon group, instead of a cyclohexyl group.

(II) Experiments:

(1) With respect to Test Example 1:

(i) Method:

A mixture of 100 parts by weight of the resin represented by the formula (Ex-1) shown below, 2 parts by weight of triphenylsulfonium nonafluorobutanesulfonate as the component (B), and 0.1 parts by weight of triethanolamine was dissolved in 1370 parts by weight of a mixture solvent of propyleneglycol monomethyl ether acetate (PGMEA) and ethyl lactate (EL) (mass ratio 8:2), thereby preparing a positive resist composition.



···(Ex-1)

Mw: 7,000

Here, the values at the bottom right of the brackets ( ) mean the percentage (molar ratio) of each structural unit.

Subsequently, an organic anti-reflective film composition ARC-29A (product name, manufactured by Brewer Science Ltd.) was applied to the surface of a silicon wafer using a spinner, and the composition was then baked and dried on a hotplate at 215°C for 60 seconds, thereby forming an organic anti-reflective film with a film thickness of 77 nm. The above positive resist composition was then applied to the surface of this organic anti-reflective film using a spinner, and was then prebaked and dried on a hotplate at 130°C for 90 seconds, thereby forming a resist layer with a film thickness of 200 nm.

This layer was then selectively irradiated with an ArF excimer laser (193 nm) through a mask pattern, using an ArF exposure apparatus NSR-S302 (manufactured by Nikon Corporation; NA (numerical aperture)=0.60, 2/3 annular illumination).

The resist was then subjected to PEB treatment at 120°C for 90 seconds, subsequently subjected to puddle development for 30 seconds at 23°C in a 2.38% by weight aqueous solution of tetramethylammonium hydroxide, and was then washed for 20 seconds with water, and dried, thus forming a resist pattern.

Subsequently, the resolution limit, depth of focus (DOF), and mask error factor (MEF) were determined in the same manner as those described in the present application.

(ii) Results:

As a result of forming a resist pattern above, a dense contact hole pattern (pitch 300 nm) with a hole diameter of 140 nm was obtained. The sensitivity (Eop) for the above hole pattern was 26 mJ/cm^2, and the resolution limit at the above Eop was 120 nm.

Also, at the above Eop, the depth of focus (DOF) and mask error factor (MEF) were measured. As a result, the DOF was 800 nm (see FIG. A shown below) and the MEF was 1.63.

FIG. A

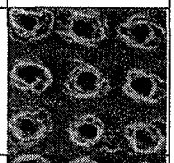
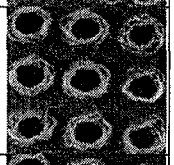
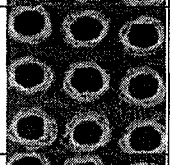
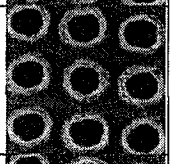
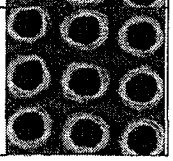
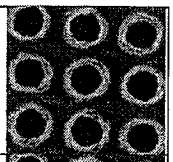
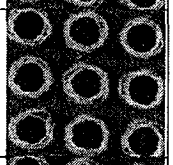
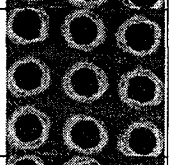
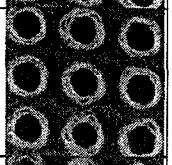
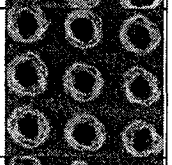
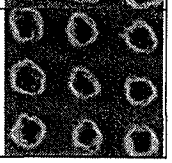
DOF (nm)	CD (nm)	PHOTO
-400	-	
-300	111.6	
-200	122.5	
-100	137.2	
0	139.6	
100	138	
200	140.9	
300	132.4	
400	120.5	
500	93.3	
600		

Table A

	Sensitivity (mJ/cm^2)	Resolution limit (nm)	DOF (nm)	MEF
Test Example 1	**26**	**120**	**800**	**1.63**
Example 3	25	130	500	1.65
Comparative Example 2	30	130	400	1.97

(In the Table A, the data of Example 3 and Comparative Example 2 are the same as those described in the present application.)

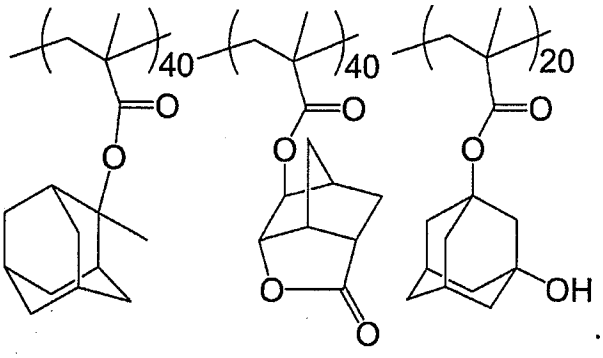
(iii)Conclusion:

From the results above, it could be confirmed that if a resist resin component which contains a combination of the structural units represented by the formula (Ex-1) shown above was used, the positive resist composition could attain superior effects in all of resolution, DOF, and MEF, as compared with those of Comparative Example 2 of the present application.

(2) With respect to Comparative Test Example 1:

(i) Method:

A mixture of 100 parts by weight of the resin represented by the formula (Ex-2) shown below, 2.0 parts by weight of diphenyl-4-methylphenylsulfonium nonafluorobutanesulfonate and 0.8 parts by weight of tri(tert-butylphenyl)sulfonium trifluoromethanesulfonate as the component (B), and 0.25 parts by weight of triethanolamine as the component (D) was dissolved in 25 parts by weight of γ-butyrolactone and 987 parts by weight of a mixture solvent of propyleneglycol monomethyl ether acetate (PGMEA) and ethyl lactate (EL) (mass ratio 8:2), thereby preparing a positive resist composition.



···(Ex-2)

Mw: 10,000

Here, the values at the bottom right of the brackets ( ) mean the percentage (molar ratio) of each structural unit.

Subsequently, an organic anti-reflective film composition ARC-29A (product name, manufactured by Brewer Science Ltd.) was applied to the surface of a silicon wafer using a spinner, and the composition was then baked and dried on a hotplate at 215°C for 60 seconds, thereby forming an organic anti-reflective film with a film thickness of 77 nm. The above positive resist composition was then applied to the surface of this organic anti-reflective film using a spinner, and was then prebaked and dried on a hotplate at 130°C for 90 seconds, thereby forming a resist layer with a film thickness of 300 nm.

This layer was then selectively irradiated with an ArF excimer laser (193 nm) through a mask pattern, using an ArF exposure apparatus NSR-S302 (manufactured by Nikon Corporation; NA (numerical aperture)=0.60, 2/3 annular illumination).

The resist was then subjected to PEB treatment at 130°C for 90 seconds, subsequently subjected to puddle development for 30 seconds at 23°C in a 2.38% by weight aqueous solution of tetramethylammonium hydroxide, and was then washed for 20 seconds with water, and dried, thus forming a resist pattern.

Subsequently, the resolution limit, depth of focus (DOF), mask error factor (MEF), and line edge roughness (LER) were determined in the same manner as those described in the present application.

(ii) Results:

As a result, the resolution limit for a trench pattern obtained by using the positive resist composition of the Comparative Test Example 1, when using the same exposure dose as that required to transfer a 130 nm mask at 130 nm, was 120 nm.

Also, a line and space (L&S) pattern was formed in the same manner as those described above using mask patterns with L&S spaces of 120 nm and 200 nm, and the MEF was determined. As a result, the MEF was 0.34.

Furthermore, the 3σ value, which is an indicator of the LER, was also determined for the 120 nm line and space (L&S) pattern formed above. The result indicated a 3σ value for the pattern was 8.3 nm.

Also, the sensitivity was 21 mJ/cm^2, and the depth of focus (DOF) for a trench pattern with a 130 nm space portion was 300 nm (see FIG. B).

FIG. B

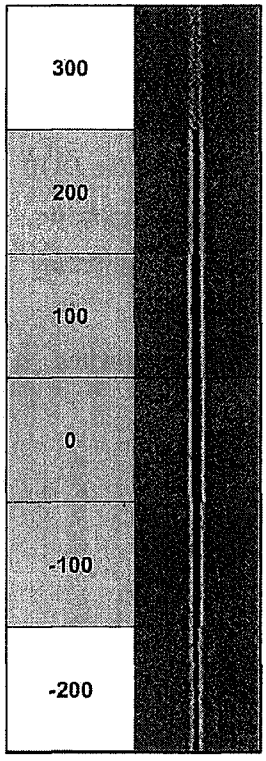


Table B

	Sensitivity (mJ/cm^2)	Resolution limit (nm)	DOF (nm)	MEF	LER (nm)
Example 1	31	110	600	0.96	4.3
Example 2	33	110	500	0.86	5.3
Comparative Example 1	29	110	400	0.66	6.5
Comparative Test Example 1	**21**	**120**	**300**	**0.34**	**8.3**

(In the Table B, the data of Examples 1 and 2, and Comparative Example 1 are the same as those described in the present application.)

(iii) Conclusion:

From the results above, it could be confirmed that if a resist resin component which contains the structural units represented by the formula (Ex-2) shown above was used, the positive resist composition cannot attain the effects in all of resolution, DOF, MEF, and LER, as compared with those of Example 1 and 2 of the present application. That is, if the structural unit which includes an acid dissociable, dissolution inhibiting group containing a polycyclic aliphatic hydrocarbon group is used instead of a cyclohexyl group, the effects of the present invention cannot be attained even when using the structural unit represented by general formula (V).

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine, imprisonment, or both, under section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Hideo Hada

Hideo HADA

May 28, 2009

Date